Simulation of Convective Initiation during IHOP_2002 Using the Flux-Adjusting Surface Data Assimilation System (FASDAS)

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ABSTRACT

The Flux-Adjusting Surface Data Assimilation System (FASDAS) uses the surface observational analysis to directly assimilate surface layer temperature and water vapor mixing ratio and to indirectly assimilate soil moisture and soil temperature in numerical model predictions. Both soil moisture and soil temperature are important variables in the development of deep convection. In this study, FASDAS coupled within the fifth-generation Pennsylvania State University–NCAR Mesoscale Model (MM5) was used to study convective initiation over the International H_2O Project (IHOP_2002) region, utilizing the analyzed surface observations collected during IHOP_2002. Two 72-h numerical simulations were performed. A control simulation was run that assimilated all available IHOP_2002 measurements into the standard MM5 four-dimensional data assimilation. An experimental simulation was also performed that assimilated all available IHOP_2002 measurements into the FASDAS version of the MM5, where surface observations were used for the FASDAS coupling. Results from this case study suggest that the use of FASDAS in the experimental simulation led to the generation of greater amounts of precipitation over a more widespread area as compared to the standard MM5 FDDA used in the control simulation. This improved performance is attributed to better simulation of surface heat fluxes and their gradients.

1. Introduction

As reliance on numerical weather prediction models continues to increase, more accurate and detailed data assimilation systems are essential. Data assimilation is based on the concept of combining current and past meteorological data in an explicit dynamical model. Four-dimensional data assimilation (FDDA) is the time-dependent dynamical coupling of various numerical fields with the model's prognostic equations. FDDA provides a logical extension between objective analysis methods and dynamic relationships of atmospheric variables.

At least two types of sequential FDDA are currently used in operational and research models. The first is a process of initializing an explicit prediction model, using subsequent forecast cycles (typically 3–12 h) as a first guess in the static three-dimensional objective analysis, and then repeating this step for future forecasts. This process is used in many current operational forecast models. A second common method of FDDA uses a continuous (i.e., every time step) dynamical assimilation where forcing functions are added to the governing equations to "nudge" the model state toward the observations. This type of FDDA is often used in the research community to study various mesoscale features. Users of the fifth-generation Pennsylvania State University–National Center for Atmospheric Research (Penn State–NCAR) Mesoscale Model (MM5) modeling system frequently use continuous-nudging FDDA. Nudging was initially developed and tested by Kistler (1974) and by Anthes (1974). Refer to Stauffer and

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